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BOTANICAL PIONEERS OF THE NEBRASKA SANDHILLS

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PHYSICAL SETTING, CLIMATE, AND VEGETATION

The Nebraska Sandhills comprise an area of about 20,000 square miles, extending from about 98° 30' to 103°. Northern and southern boundaries are parallel with the Niobrara and Platte River valleys, respectively. The Sandhills merge with the Loess Hills physiographic region at the southeast, resulting in irregular interfaces of low dunes with clay bluffs and canyons of the latter region (Elder, 1969).

Average annual precipitation ranges from approximately 24 inches in the east to less than 16 inches in the west. About 75 percent of annual precipitation occurs during the period April to October, inclusive. Temperature extremes range from more than 100° F to -20° F during an average year. Mean annual wind velocity is about 10 miles per hour, with slightly greater wind movement prevailing in March and April (Sherfey, et al., 1965).

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Physiography of the Sandhills region consists of stabilized dunes alternating with dry valleys and basins. Sands derived from Pliocene Ogallala formation are thought to have been subjected to three cycles of dune formation influenced by prevailing wind direction and velocity. Dune ridges are generally aligned on west to east axes, with greatest topographic relief in the west-central part of the region (Smith, 1965). Dune sand appears to have been stabilized by vegetation at least since late Pleistocene times. Small areas subject to disturbance continue to be vulnerable to wind erosion and blowouts are likely to form when vegetation is removed. Blowouts in various stages of formation and recovery can be seen in virtually every square mile of the Sandhills.

Marshes and shallow lakes are common in parts of the region, especially the north-central and southwest. Streams are relatively few in the Sandhills; principal rivers include the Loup, Calamus, Dismal, and Cedar. These streams are all characterized by narrow valleys and relatively small variation in seasonal flows (Keech and Bentall, 1971).

Soils of the region are classified in the Valentine-Dunday association, characterized by predominantly sandy textures. Dry valleys contain relatively more particles of silt and clay sizes, while dunes consist mostly of fine to medium sand. Absorptive capacity of nearly all Sandhills soils is such that virtually no surface runoff of precipitation occurs. Soil profiles lack typical horizons and little accumulation of organic matter occurs at or near the surface. Plant roots penetrate the soil readily and are able to reach constant moisture supplies lying relatively near the surface (Elder, 1969).

Grasses comprise the dominant life form of the region's vegetation. Kuchler (1964) termed the potential natural vegetation of the area Sandhills Grassland, with *Andropogon* and *Calamovilfa* providing the diagnostic genera. *Panicum*, *Stipa*, and *Eragrostis* are also important components. Typical forb constituents include members of the families Leguminosae, Compositae, Polygonaceae, and Asclepidaceae. Woody plants of the region are of comparatively few species, but low shrubs make up significant parts of vegetation of all soil and topographic combinations. Rose (*Rosa* spp.), leadplant (*Amorpha canescens*), sandcherry (*Prunus besseyi*), and redroot (*Ceanothus ovatus*) are among the more common shrubs. The narrow floodplains and canyon walls of major streams support sparse to moderate stands of mixed deciduous trees and redcedar (*Juniperus* spp.). Small stands of hackberry (*Celtis occidentalis*) are found far from stream valleys, usually on middle portions of steep south slopes.

The Sandhills was not a region that particularly invited the exploration or scientific trips often associated with other parts of the continent. Had it not been for the river systems that originated in the "hills", it is doubtful that this area would have been explored until well into the 1800's.

This unique and often harsh region did see, though, a number of early-day travelers, some not particularly inclined toward the botanical side, but of keen observation so that reasonably good descriptions were set down. Later, many of the "classic" botanists appeared on the scene, and recorded detailed observations on the ecosystems of the region -- some so complete that little improvement has been made to their early works.

Looking at some of these early explorers and botanists of the Sandhills, we find that James Mackay was one of the first to record his impressions.

JAMES MACKAY

"Great deserts of drifting sand without trees, soil, rocks, water, or animals of any kind, excepting some little varicolored turtles, of which there are vast numbers ... Found here the middle part of the thigh-bone of an animal, the large end of which was 7 inches in diameter and the other 6 3/4 inches ... In these marshes there is some wild rice ... Sandy hilly country." These fragmentary natural history notes by James Mackay, written in 1796, represent the first recorded observations of the Nebraska Sandhills. Mackay was the leader of an expedition of the Upper Missouri Company of St. Louis which established a post in extreme northeastern Nebraska. A few earlier explorers are thought to have crossed central Nebraska --- Bourgmund in 1714, Villasur in 1720, and the Mallet brothers in 1739 --- but nothing is known about their routes (Diller, 1955).

Lt. G.K. WARREN

Warren's 1855 route through the Sandhills was the middle part of an exploration from Ft. Pierre on the Missouri to Ft. Kearny on the Platte. His contingent left Ft. Pierre August 9 and reached Ft. Kearny August 25. Camp sites in and near the Sandhills included the Niobrara Valley on August 14, near Calamus River August 17, and on Middle Loup River August 19.

Warren's 1857 expedition left Sioux City on July 6, 1857 for the mouth of the Loup Fork of the Platte River. From here Warren, in company with J. Hudson Snowden, a topographer, proceeded westward. The command inched its way slowly through quicksand and terrain made difficult by the numerous creeks emptying into the Platte. Within 50 miles, the Loup Fork closed down to a gorge through which the wagons could not pass.

At this point, a teamster member of the party came down with typhoid fever. To allow recovery, the expedition halted and Warren spent time investigating the nature of the surrounding country. The harsh nature of the Sandhills certainly made its effects felt. Warren's account in early August indicated "We have now traced the river (Loup) from end to end and found the impracticality for almost any purpose so marked that it seems like a great waste of time to have made the exertion we have. Our greatest wish is to get away from it (the Sandhills) as soon as possible and never return."

While Warren moved on with his men to Ft. Laramie, Snowden apparently stayed in the region of the Upper Niobrara until rejoining Warren on October 15. During this time Snowden had thoroughly examined, mapped and studied a large area of land bordering the Niobrara.

Assigned to Washington in late 1857, Warren labored almost a year to prepare his reports on travels in the Missouri River basin country. Certainly his "Preliminary Report of Exploration in Nebraska and Dakota" provided an important cataloging of the resources of the Sandhills--even though much of the identification and commentary on the flora and fauna was provided by others.

Chapters covering the general routes of travel, geography and geology, climate, descriptions of the river systems, Indians and the military, and natural history make interesting reading. The catalog of plants collected during the three years of exploration shows a total of 593 species, with notes on distribution, abundance and occasional references to medicinal or ritual use among the natives. The majority of collections were made adjacent to the Missouri River, but central Nebraska is well represented, especially the areas adjacent to the Platte and Loup rivers (Warren, 1875). F.V. Hayden, later of the U.S. Geological survey, accompanied Warren's 1857 exploration in the capacity of geologist and naturalist.

F.V. HAYDEN

In the late 1860's, F.V. Hayden recorded a number of botanical observations during the course of extensive geological explorations in the Great Plains. Hayden described the geographical boundaries of the Sandhills as the Niobrara River at the north and the Platte River at the south and estimated their area at 20,000 square miles. Among his writings, there are references to the alkaline marshes and shallow lakes in the region, which he distinguished by lack of vegetation around the borders. Hayden's description of Sandhills blowouts, though brief, contains the essential features of this landform. "The whole surface is dotted over with conical hills of moving sand. These hills often look like craters or small basins, the wind whirling and, as it were, scooping out the sand, leaving innumerable depressions with a well-defined circular rim." He noted the adaptation of the region's common plants to sandy substrate and made reference to hillsides

literally covered with *Yucca*. Hayden also emphasized that the region was not suited to intensive agriculture, and that even grazing would have limitations (Hayden, 1873).

P.A. RYDBERG

P.A. Rydberg (1895) conducted a three-month botanical exploration of three counties in the central Sandhills in the summer of 1893. During the course of his investigation, he collected 600 herbarium specimens (about 200 species) in 16 localities. Rydberg described four topographic types in the region: river valleys, dunes, dry valleys, and wet meadows. Among the dominant plant species, he singled out sand bluestem (*Andropogon hallii*), little bluestem (*Andropogon scoparius*), needle-and-thread (*Stipa comata*), one sedge, four shrubs, and 22 forbs (including three legumes, four composites, and three milkweeds). In the dry valley site, 12 additional forb species were identified while the aquatic flora included three species each of duckweed, pondweed, and emergent rooted plants. Rydberg also enumerated 24 "weeds", both native and introduced which he observed thriving on disturbed sites. He further speculated optimistically about the possibilities of large-scale coniferous tree plantings, as well as adding exotic grasses and legumes to the native forage plants.

JARED SMITH

A statement made by Jared Smith before the turn of the century and quoted in Bessey (1900) is appropriate in modern range management. Smith was writing with special reference to the Sandhills, but it is applicable

to all rangeland. " ... the one great mistake in the treatment of cattle ranges, the one which always proves most disastrous from a financial standpoint, is overstocking. ... The maximum number of cattle that can safely be carried on any square mile of territory is the number that the land will support during a poor season. Whenever this rule is ignored there is bound to be loss. ... It may seem like throwing away money not to have all the grass eaten down, but in the long run there will be more profit if there are fewer head carried per square mile."

C.E. BESSEY

Of all the pioneering botanists intrigued by the Nebraska Sandhills, Charles E. Bessey has probably left a more permanent reminder of his botanical zeal and enthusiasm than any other early investigator.

The 206,028 acre "forest reserves" set aside near Valentine and Halsey will stand forever as a monument to Bessey's persistence. The fact that this was the first and only instance in which the federal government removed non-forested public domain from settlement to create a man-made forest reserve is worthy of historical note alone. That an unassuming botany professor brought a forest into being in such an uncharacteristic setting is worth a short discourse by itself.

Coming from ISU at Ames in 1884, Bessey found at the University of Nebraska plenty of opportunity for his botanical interests. With students or by himself, he traveled widely over the state collecting and describing Nebraska flora. His interest in the vegetation of the Sandhills was high from the very beginning. One aspect of Bessey's studies included digging

test holes in many places. At each digging he always found moisture within a few inches of the surface, no matter how dry or hot the topsoil. Recalling similar conditions in Michigan, it seemed "quite likely" to him that the moist soil of the Sandhills would bear forests once trees were planted. When he found western yellow pine and red cedar growing in widely scattered localities in the Sandhills, he soon became convinced that selected species of trees would grow in the region. Reports and recommendations for tree planting in the Sandhills were not long in coming. As a member of a joint committee from the State Horticultural Society and the State Board of Agriculture he petitioned the state legislature in 1887 to set aside tracts of land in the Sandhills for tree planting.

Bessey's repeated recommendation and urgings were not exactly popular with the ranchers and stockmen in the region. They insisted rather strongly that forests were plentiful elsewhere, and that public domain grasslands were established for grazing and should not be fenced off for forest experiments. Undaunted by local opposition or federal coolness, Bessey persisted in his convictions.

After making so many people miserable about the planting of pines in the Sandhills, Bessey's appeal was rewarded with a peculiar reaction from Washington. In present day vernacular it could be equated to a bureaucratic stall. If this was in fact the case, the whole scheme to get Bessey off their backs went awry--as we shall see.

In January, 1891, the Director of the Division of Forestry, Dr. B.E. Fernow contacted Bessey indicating he (the government) was ready to make the experiment of planting pines in the Sandhills, if Bessey could make land available for such purposes. Initially provoked because his duties at the University would not allow him to take care of the project and because he didn't have any land to turn over to Fernow for the government's use, Bessey "expressed himself rather emphatically as he walked up and down the corridors of Nebraska Hall". As fate would have it, a colleague and professor of entomology, Lawrence Bruner owned, along with his brothers, some land in southwestern Holt County right in the heart of the Sandhills. Bruner's offer of the land paved the way for an agreement with the Division of Forestry. By the end of 1892, four plots of 1/4-acre each had been planted with four species. The harsh climate of the Sandhills took its toll, however, on the new plantings. Where one plot had been plowed, the trees died and a blowout developed. Western yellow pine and jack pine survived where they had been furrow-planted, and reports were favorable. Within several years the plantation dropped out of sight and no further reports were made. In the meantime, Bessey continued to campaign for reforestation of the Sandhills, making continued pleas to the State Horticultural Society and through reports to the State Board of Agriculture.

Suddenly, the fruits of Bessey's ceaseless lobbying showed signs of promise. In 1901, a reconnaissance party of the U.S. Bureau of Forestry arrived to examine forest conditions in Nebraska. Much to the surprise of even Bessey, they found trees planted 10 years earlier on the all-but-forgotten Bruner tract had attained heights of 18 to 20 feet, and had formed a dense thicket on the rolling Sandhills north of Swan Lake. When

Bessey learned of this, and of the party leader's (William L. Hall) favorable impressions, he realized that his long-held dream was close to reality. Pushing on relentlessly, he lobbied with anybody who could possibly influence a decision, beginning with prominent citizens and ending with Gifford Pinchot who had recently taken over as Chief of the Bureau of Forestry, USDA. With a favorable report by the government party, the long quest ended in April, 1902 when Theodore Roosevelt set aside two reserves totaling 206,028 acres. In later years, the 96,000-acre tract near Halsey was designated the Bessey Division; the 110,000-acre tract near Nenzel the Niobrara Division.

Tree planting began in 1903 and progressed through the early 1900's until approximately 30,000 acres had been planted. While jack pine and Scotch pine did not fare well during the droughty 1930's, ponderosa pine and redcedar demonstrated the potential of the sandy dunes for growing trees.

Other ecological considerations aside, the Bessey Division forest is impressive as an unusual botanical entity in a unique setting.

While one might question whether Bessey's quest was wise in light of today's movement toward (or back to) native vegetation, one lesson might be had for us all in examining his contributions. By today's standards he might be classified a "radical environmentalist". But his dogged persistence, patience, and commitment to battle all the way to the top, clashing with vested interest groups and top government officials,

made his dreamed-of changes possible. How many of us have had the patience or perseverance to see a battle through? Bessey's philosophy of total commitment serves today as an even more important standard in the battle for environmental quality.

R.J. POOL

The most intensive study of Sandhills vegetation was done as a doctoral dissertation by R.J. Pool and was published in the University of Minnesota Botanical Studies (Pool, 1914). The study was prefaced with a concise treatment of the region's geology and climate, with the main part presenting detailed descriptions of plant communities. Environmental influences on vegetation received considerable emphasis. Ordination of plant assemblages, following the theories of F.E. Clements, are summarized below.

I. Upland Formations

A. Prairie grass formation

1. Bunchgrass association
2. *Muhlenbergia* association
3. Blowout association
4. Speargrass association
5. Wiregrass association

B. Short grass formation

1. Grama-buffalograss association

C. Woodland formation

1. Linden-cedar-ironwood-ash association

D. Yellow pine formation

II. Lowland Formations

A. Water plant formation

1. Pondweed association
2. Waterlily association
3. Stonewort-naiad association

B. Marsh formation

1. Bulrush-reed association
2. Smartweed association
3. Streamside marsh association

C. Meadow formation

1. Rush-sedge association
2. Water hemlock association
3. Fern meadow association
4. Hay meadow association
5. Willow thicket association

Pool theorized on geographic origins of flora components which co-mingled in the Sandhills. He stated that elements of eastern prairie, western foothills, and western montane floras were associated with what

was referred to as the "proper" vegetation which had evolved in response to environmental conditions. No detailed descriptions or lists of the various associations will be presented, but a few examples are discussed in the following paragraphs.

The bunchgrass association, which occurs on most upland sites, is dominated by sand bluestem (*Andropogon hallii*) and little bluestem (*Andropogon scoparius*). Other "principal" species included three grasses, four shrubs, and four species of forbs. The list is rounded out with 90 "secondary" species.

The blowout association, more or less limited to plants adapted to this harsh environment, is dominated by sandreed (*Calamovilfa longifolia*), blowout grass (*Redfieldia flexuosa*), and lemon scurfpea (*Psoralea lanceolata*). All of these have well-developed rhizomes which are able to grow rapidly, thus tying down the shifting sand.

Woodlands described by Pool include some that have extremely limited ranges. The largest assemblages of woody plants are found at the northern fringe of the Sandhills, especially in association with spring-fed tributaries of the Niobrara River. In the central Sandhills, trees and shrubs are more likely to be limited to about a dozen species.

Rush-sedge meadow represents a nearly complete departure from the upland herbaceous vegetation. Dominant elements include five species of *Juncus* and four *Eleocharis*. About 50 "secondary" species are also listed, only a few of which occur sparingly on other sites having less favorable moisture conditions.

The hay meadow association was described separately due to Pool's recognition of the economic importance of this vegetation type. All 13 dominant species are grasses, with some occurring in wetter or dryer situations. Of the 39 "associated" species, several also occur on prairie sites. Part of the variability of hay meadow vegetation is due to the presence of topographically low marshes or the rush-sedge type, while the "upper" edges merge with lower prairie slopes.

In addition to observation abilities, Pool also possessed a great talent for teaching. During his tenure at the University of Nebraska, field botany remained one of his primary interests. He was also a firm advocate of photographic documentation, which was used extensively in his own investigations and those of his students. Several hundred glass plate negatives and lantern slides, with date and location information, remain in the collection of the State Museum Herbarium.

SUMMARY

In retrospect, the high points in the careers of the scientists discussed in this review represent but a fraction of their contributions to humanity. They were pioneers in the truest sense of the word. Travel was by foot, on horseback or by horse-drawn vehicle. Equipment and scientific literature were limited, but the results produced would be the envy of many a modern investigator. Acute powers of observation and the ability to organize data in meaningful published form stand out in all their professional efforts. Though modified in detail, their findings remain valid in principle.

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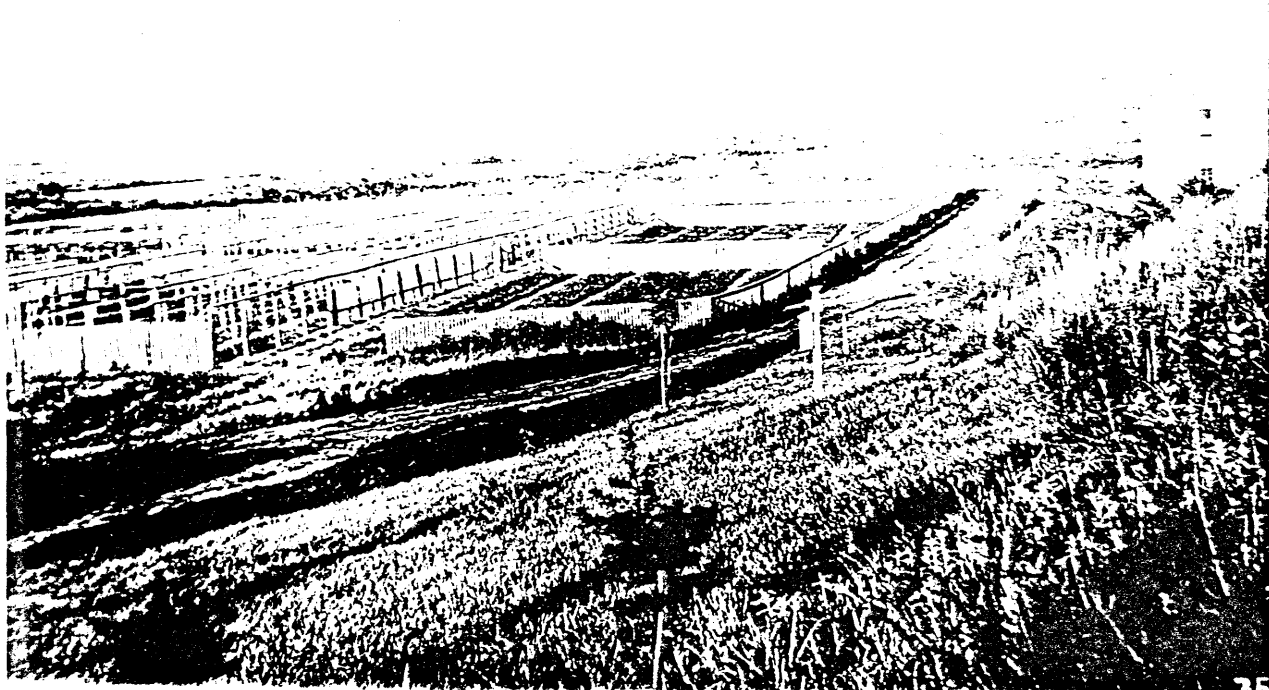
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Shallow lakes and marshes are common in the Sandhills.
Clear Lake; Cherry County; July, 1912.



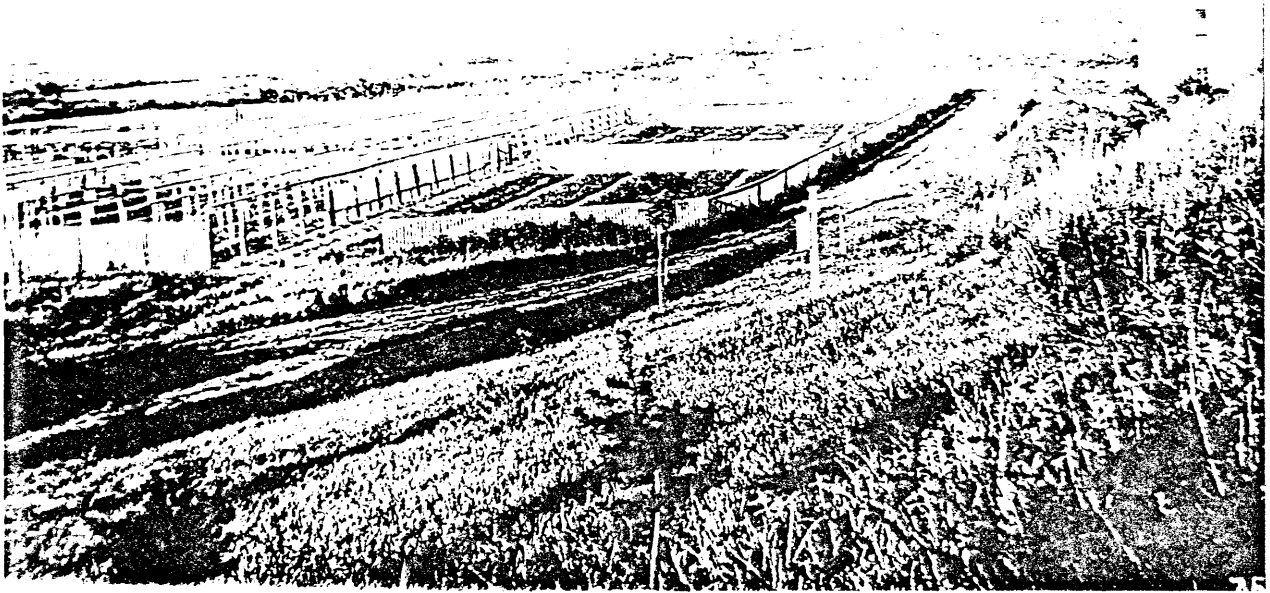
Jared Smith, USDA botanist, issued warnings before 1900 about the dangers of overgrazing. Photo taken in Thomas County; 1912.



U.S. Forest Service nursery near Halsey; 1908.



Native ponderosa pine; north-central
Cherry County; ca. 1910.



U.S. Forest Service nursery near Halsey; 1908.